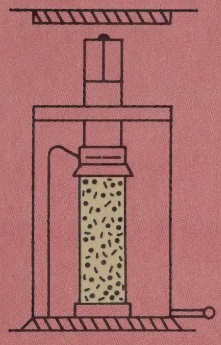
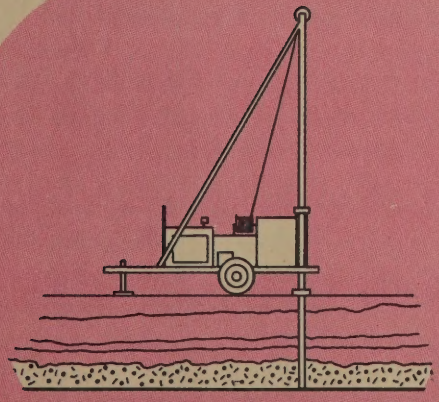
STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

SOIL MECHANICS BUREAU





CAMILLUS FAIRMOUNT PART 1

SH 5318

PAVEMENT CAVITY INVESTIGATION

DAY FILE COPY

February 27, 1979

PAVEMENT CAVITY INVESTIGATION
CAMILLUS-FAIRMOUNT, PART 1
S.H. 5318

Lyndon H. Moore, Soil Mechanics Bureau, Room 102, Bldg. 7 ORIGINAL SIGNED BY LYNDON H. MOORE

Joseph M. Powers, Regional Director, Region 3

Attached please find three (3) copies of a memorandum prepared by Mr. F. R. Irving describing the geologic conditions and the down-hole electromagnetic (EM) cavity survey results at the subject site. This work was conducted by Lawrence Livermore Laboratory of California as part of an FHWA field research project.

Please schedule the requested drill holes as soon as convenient. We would appreciate it if Mr. Small would contact Mr. Irving before starting the work.

LHM:sd
Attachments

NYSDOT
Library
50 Wolf Road, POD 34
Albany, New York 12232

DAY FILE COPY

February 27, 1979

PAVEMENT CAVITY INVESTIGATION
CAMILLUS-FAIRMOUNT, PART I
S.H. 5318

Lyndon H. Moore, Soil Mechanics Bureau, Room 102, Bldg. 7

Joseph M. Powers, Regional Director, Region 3

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NYSDOT
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50 Wolf Road, POD 34
Albany, New York 12232

DAY FILE COPY

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

DATE February 13, 1979

SUBJECT PAVEMENT CAVITY INVESTIGATION
CAMILLUS BYPASS -- SH 5318

February 27, 1979

FROM F. R. Irving, Associate Engineering Geologist

TO L. H. Moore, Director, Soil Mechanics Bureau

Mr. Victor E. Taylor
Division Administrator
Federal Highway Administration
New York Division
Leo W. O'Brien Federal Building, Ninth Floor
Clinton Avenue and North Pearl Street
Albany, New York 12207

Dear Mr. Taylor:

RE: Camillus-Fairmount, Rte. 5
I-890, Schenectady Spur
Glens Falls Feeder Canal

The attached memorandum by Mr. F. R. Irving describes the geologic conditions and down-hole electromagnetic (EM) survey results for pavement cavities at the Camillus site. This work was conducted by Lawrence Livermore Laboratories. The surficial EM survey conducted by ENSCO did not yield results at any of the three sites due to high losses in the surficial materials. ENSCO did try a down-hole EM probe at I-890, Schenectady Spur; however their equipment malfunctioned before it could be determined if the method would yield useful results. It is our understanding that they will visit this site again in the spring.

We wish to extend our appreciation to you for making the arrangements for this project and to Dr. Linger and his staff for scheduling and conducting the work. The attached report was requested by Dr. Linger for documentation of the field research experiment.

Very truly yours,

ORIGINAL SIGNED BY
LYNDON H. MOORE

Lyndon H. Moore, Director
Soil Mechanics Bureau

cc: Dr. Linger, Federal Highway Administration

Att.

DAY FILE COPY

February 27, 1979

Mr. Victor K. Taylor
Division Administrator
Federal Highway Administration
New York Division
Leo W. O'Brien Federal Building, Ninth Floor
Clinton Avenue and North Pearl Street
Albany, New York 12207

Dear Mr. Taylor:

RE: Camillus-Fairmount, Mile. 3
I-690, Schenectady Spur
Glens Falls Feeder Canal

The attached memorandum by Mr. P. R. Irving describes the geologic conditions and down-hole electromagnetic (EM) survey results for pavement cavities at the Camillus site. This work was conducted by Lawrence Livermore Laboratories. The surficial EM survey conducted by ENSCO did not yield results at any of the three sites due to high losses in the surficial materials. ENSCO did try a down-hole EM probe at I-690, Schenectady Spur; however their equipment malfunctioned before it could be determined if the method would yield useful results. It is our understanding that they will visit this site again in the spring.

We wish to extend our appreciation to you for making the arrangements for this project and to Dr. Linger and his staff for scheduling and conducting the work. The attached report was requested by Dr. Linger for documentation of the field research experiment.

Very truly yours,

Lyndon R. Moore, Director
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MEMORANDUM
DEPARTMENT OF TRANSPORTATION

DATE February 13, 1979

SUBJECT PAVEMENT CAVITY INVESTIGATION
CAMILLUS BYPASS -- SH 5318

FROM F. R. Irving, Associate Engineering Geologist

TO L. H. Moore, Director, Soil Mechanics Bureau

Several sinks appeared toward the end of construction on the subject project. The area in question is a four lane divided highway on a 4.4% grade. The highway is in a fifteen to twenty foot deep cut in till and weathered shale. The sinks appeared in the cut slope, ditchline and shoulder. The sinks were thought to be related to cavities in the underlying bedrock.

The initial remedial steps taken after filling the sinks consisted of placing an impervious membrane in the ditches to prevent further piping of material down into the cavities and injecting grout into the areas where sinks had appeared close to the pavement. Grout take ranged from 0 up to 92 bags of cement (nominal 1 to 3 mix) representing some 8 to 10 cubic yards -- depending on mix. Most of the grout take was 15 to 20 feet below grade (maximum depth of grout holes).

The bedrock at the Camillus site consists of a series of badly weathered soft shales, dolomites and evaporite residue belonging to the Syracuse Formation. It lies between the Camillus shales above and the Vernon shales below. The Syracuse Formation was formerly considered to be part of the Camillus shales.

The Syracuse Formation is estimated from composite outcrop sections to be 150 feet thick in this area. It contains beds of evaporites which consist of salt and anhydride in areas to the south where the formation is encountered in deep drill holes. In the outcrop area where large scale solution has taken place, the evaporites are represented by two beds of structureless gray clay-like residue with blocks of gypsum included in them. These beds are each about 12± feet thick where observed in outcrops but probably thicker and more variable where some cover exists. The upper bed is overlain by a 15± foot thick dolomite member which marks the top of the formation. The lower bed is separated from the upper by 35 to 45 feet of gray to brown shales and dolomites and is underlain by 70 to 80 feet of thin gray dolomites and dull green shales.

Drill holes at the site indicate till and/or weathered brown shales down to elevation 498±. Between elevation 498± and 483± there is a layer of soft weathered brown to gray shales containing the "cavities." From elevation 483± down to elevation 469± there is weathered yellow-brown/gray-green shales. Below elevation 469± there are light to dark gray shales with thin dolomite layers. Samples above elevation 469± were taken with a drive spoon. The rock was cored below that elevation. Complete loss of drilling water occurred in four out of the five holes that penetrated below elevation 469±. A few holes also temporarily lost water above that elevation in the cased portion of the hole. The deepest hole at the site, the extension of I.M. 2-2, penetrated to elevation 435 without encountering ground water.

Settlement due to solution of the evaporites in the outcrop area caused a great deal of distress in the overlying beds. Ground water percolation through the resultant fractures contributed to the highly weathered condition of the rocks at this site.

Information presently available at the site is not conclusive but the indications are that the sinks are due to collapse of cavities that occur in the lower residue bed. The sinks that are visible in the field to the north of the site are probably associated with the upper residue bed.

Experience with the upper residue bed at the Upstate Medical Center in Syracuse and a similar bed in the overlying Bertie group at Forest Interchange on Route I-481 just south of the city indicates that where encountered under some cover by drill holes or excavations, these beds are very likely to contain cavities. The cavities generally range up to five feet in diameter with occasional ones somewhat larger. They may be empty or refilled with soft black silty clay or secondary gypsum deposits.

Two different high frequency electromagnetic geophysical methods for locating cavities were tried at this site during late November and early December of last year. The first method was a surface scan type. The ENSCO Company of Washington, D.C. conducted this part of the project. Their equipment employs separate transmitting and receiving antennas which are towed along the ground. Reflected signals from the transmitting antenna are picked up by the receiving antenna and recorded on a strip chart. The resulting record resembles a fathometer or sub-bottom profiling record. This method did not yield any usable data at this site due to high losses in the glacial till and weathered shale.

The second high frequency electromagnetic method used was a cross-hole technique which used a transmitting antenna in one hole and a receiving antenna in a second hole. This part of the work was conducted by Mr. J. Lytle and Mr. E. Laine of Lawrence Livermore Laboratory of Livermore, California. Their procedure consisted of simultaneously lowering both antennas down adjacent drill holes and recording areas of high signal loss caused by differaction at the cavity boundaries. If both antennas are at the same elevation a horizontal "view" of the cavity is obtained. By varying the vertical position of the antennas with respect to each other a number of oblique "views" of the cavity can be obtained and its relative position and size in the plane of the drill holes obtained by a simple graphical analysis. The nine drill holes used on this project were pre-drilled by State forces. Three rows of three holes each were used; one row on each outside shoulder, and one in the center of the mall. The holes were spaced thirty feet apart in the rows and the rows were sixty feet apart. The holes were 30-34 feet deep, all bottoming at the same elevation except for the middle hole which was deepened to 40 feet during the survey. All holes were lined with plastic. The method appeared to give excellent results at the thirty foot spacing, but the signal losses at the sixty foot spacing proved to be too high in this material to give usable results. The 30± foot hole depth limited the angle of the oblique views that could be taken which somewhat limits the ability of

the method to delineate the size and location of the cavity.

The accompanying sections show the approximate location of the anomalies, presumably cavities as indicated by the cross-hole E.M. survey. As stated in the attached letter from Mr. Laine some may be grout filled. It should be noted that "cavities" were found between all the drill holes from which data was obtained and therefore it would seem logical that "cavities" do exist under the pavement outside the grouted areas.

As a first step the results of the cross-hole survey should be checked out by N.X. drill holes at the following points:

Between holes 1-1 and 2-1; 15' from 1-1
Between holes 2-3 and 3-3; 18' from 2-3
Between holes 1-3 and 2-3; 13' from 1-3.

In addition to checking out the cross-hole survey results these holes should yield additional information on the nature and extent of the cavities. The points of special interest are:

1. Do the "cavities" contain actual voids or have they been refilled. Present information indicates that both these conditions exist.

2. If voids are present -- to what extent are they interconnected?

3. What is the largest size void that can reasonably be expected?

4. Are there any voids large enough or close enough to the surface to collapse even without the reduction of shear strength and/or piping of the overlying material caused by infiltration of ground water?

If the drill data indicates that large voids are present then additional work should be done at this site. The additional work should include a down-hole E.M. survey across the pavement using holes placed no further than forty feet apart. These holes should go down to at least elevation 470. This phase of the work should proceed westward (upgrade) far enough to insure that a thickness of overburden several times the diameter of the largest void anticipated exists above the cavity zone, probably to Station W.B. 83+. Any cavities indicated by this survey should be pressure grouted. If large volumns are anticipated then a bulking agent can be added to the grout. Consideration may also have to be given to extending the plastic lining recommended in the August 18, 1977, memorandum from L.H. Moore to J.M. Powers. Any extension would be to the west.

FRI:sd

LAWRENCE LIVERMORE LABORATORY

Electronics Engineering Department

January 4, 1979
WT79-0011C

Dr. Donald A. Linger
Department of Transportation
Federal Highway Administration
Office of Research (HRS-11)
Washington, D. C. 20590

Dear Dr. Linger:

I am enclosing projected views of anomalies we discovered in the prospect holes along the I-5 bypass near the Camillus overpass Syracuse, New York.

The previous grouting in this area adds another dimension to the interpretation, but in each case, the projected anomaly represents a zone of high contrast to electromagnetic waves. This effect can be produced by a void, a cavity filled with high conductivity water, a metallic pipe, or a grouted zone. One can employ some logic to rule out a cavity filled with water as the area is apparently quite permeable, hence drainage is good. Metallic pipes can also be ruled out since the location of pipes or culverts should be well known. This leaves a cavity and grouted cavities as the most likely suspects. The grouting plan view of this area shows no grouting in the mid section of the highway, heavy grouting in the west bound lanes, with grout holes between 3-2 and 3-3 and a single line of grout holes in the east bound lanes. Our recommendation is to core drill into each of the indicated anomalies to determine the validity of this probing.

Probing was attempted across the traffic lanes, 60 feet, but the media is too lossy to transmit an acceptable signal using our present system. All probing parallel to the traffic lanes (30 foot hole separation) was done at 60 Megahertz. The measured conductivity of the general media was 10^{-2} siemens (mhos/meter). The rock underlying the surface till was less lossy. If cross-borehole EM probing is used at a later date, we strongly urge that the boreholes be drilled at least 20 to 30 feet deeper than the desired investigation depth. This allows us to use steeper skewed lines of probing to get better spatial location of anomalous areas and to reduce surface effects (reflections from the near surface).

University of California
P.O. Box 5504
Livermore, California 94550

Telephone [415] 422-1100
FTS 532-1100
Twx 910-386-8339 DOE LLL LVMR

We wish to thank Jim Small and his crew at the Syracuse office of NYDOT for their enthusiastic support. Frank Irving and Ross Sangster were of great assistance in performing this work and also aided us with their cogent comments, interest and efficiency. These personnel made our task go smoothly.

If there are any questions, please call either Jeff Lytle at (415) 422-9162 or myself at (415) 422-8811.

Sincerely,

Ed Laine

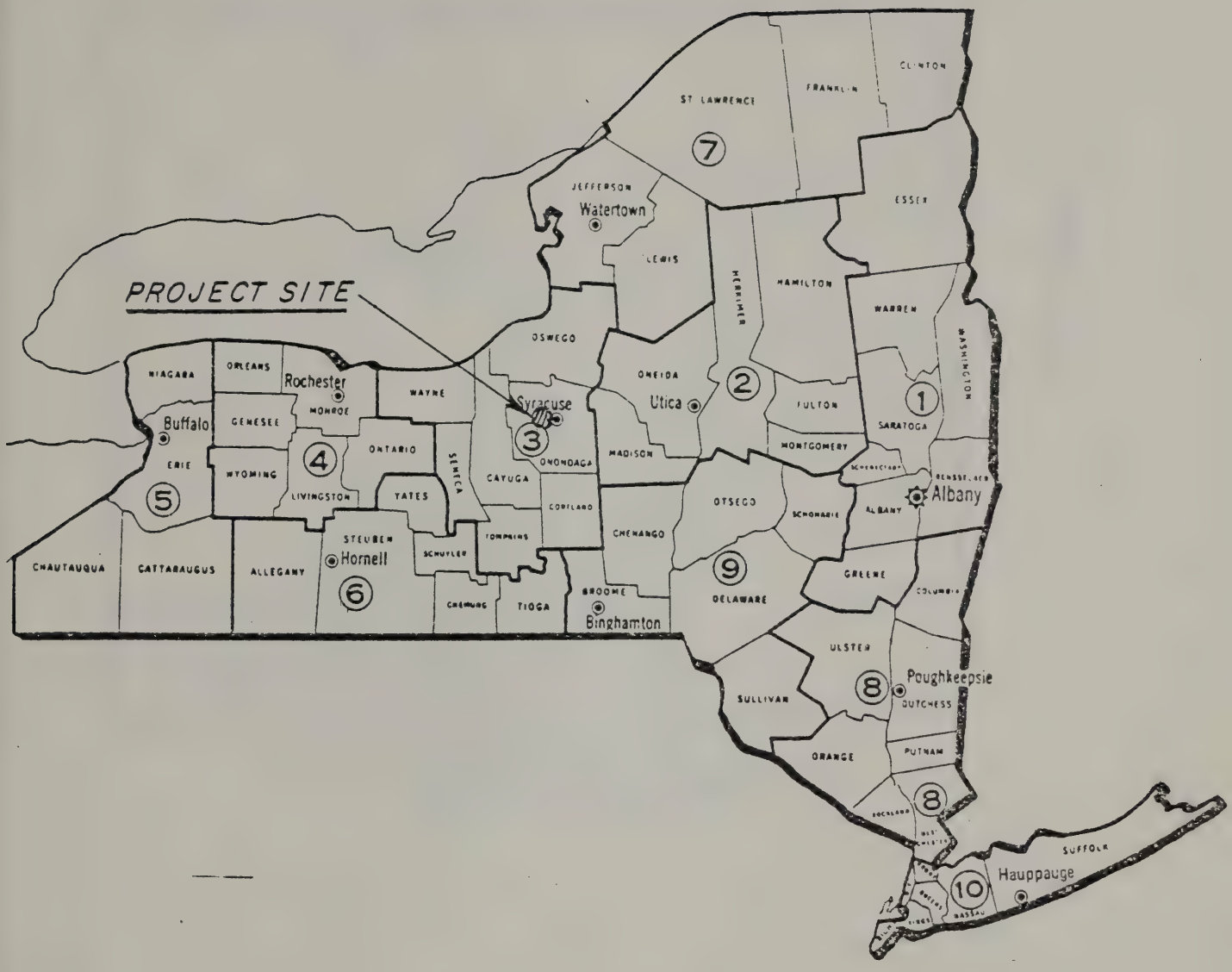
E. F. LAINE
Electronics Engineering Department

jb

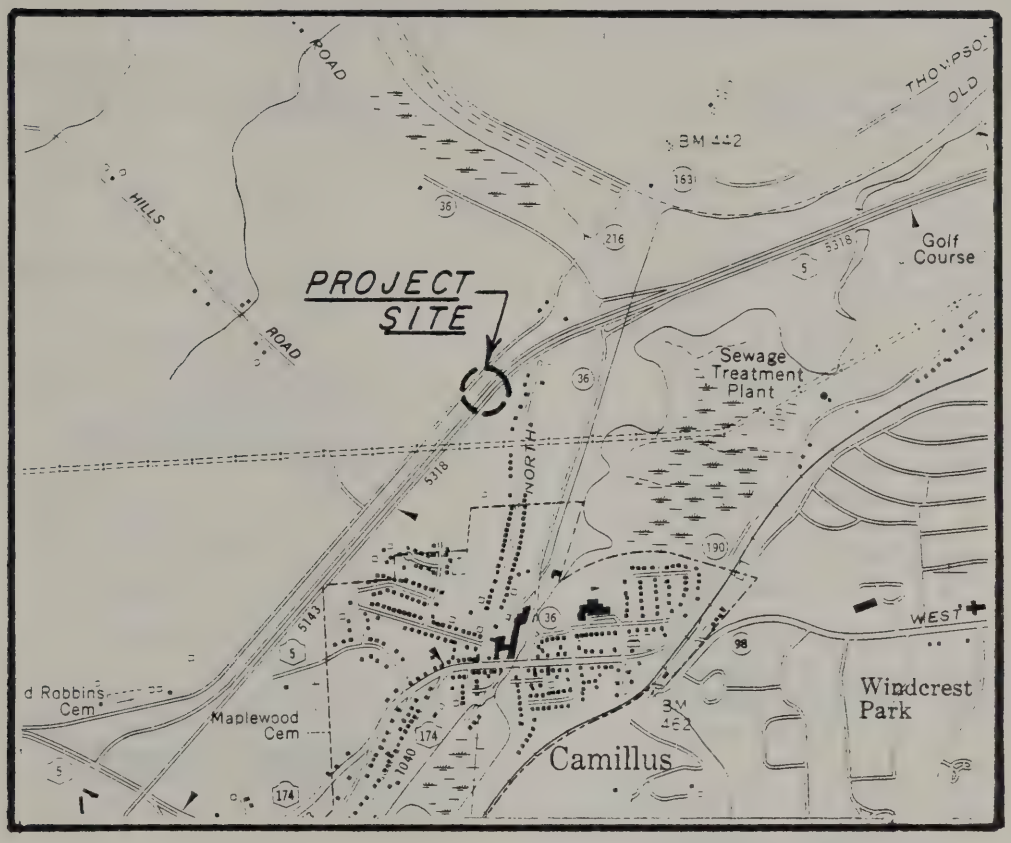
Copy to:
R. J. Lytle
Dr. Roger Sinha

Frank Irving
(NYDOT) Soil Mechanics Bureau
Building 7, State Campus
Albany, NY 12232

Lyndon H. Moore, Director
Soil Mechanics Bureau
N. Y. Department of Transportation
Building 7, State Campus
Albany, New York 12232



CAMILLUS FAIRMOUNT-PART I
S.H. 5318



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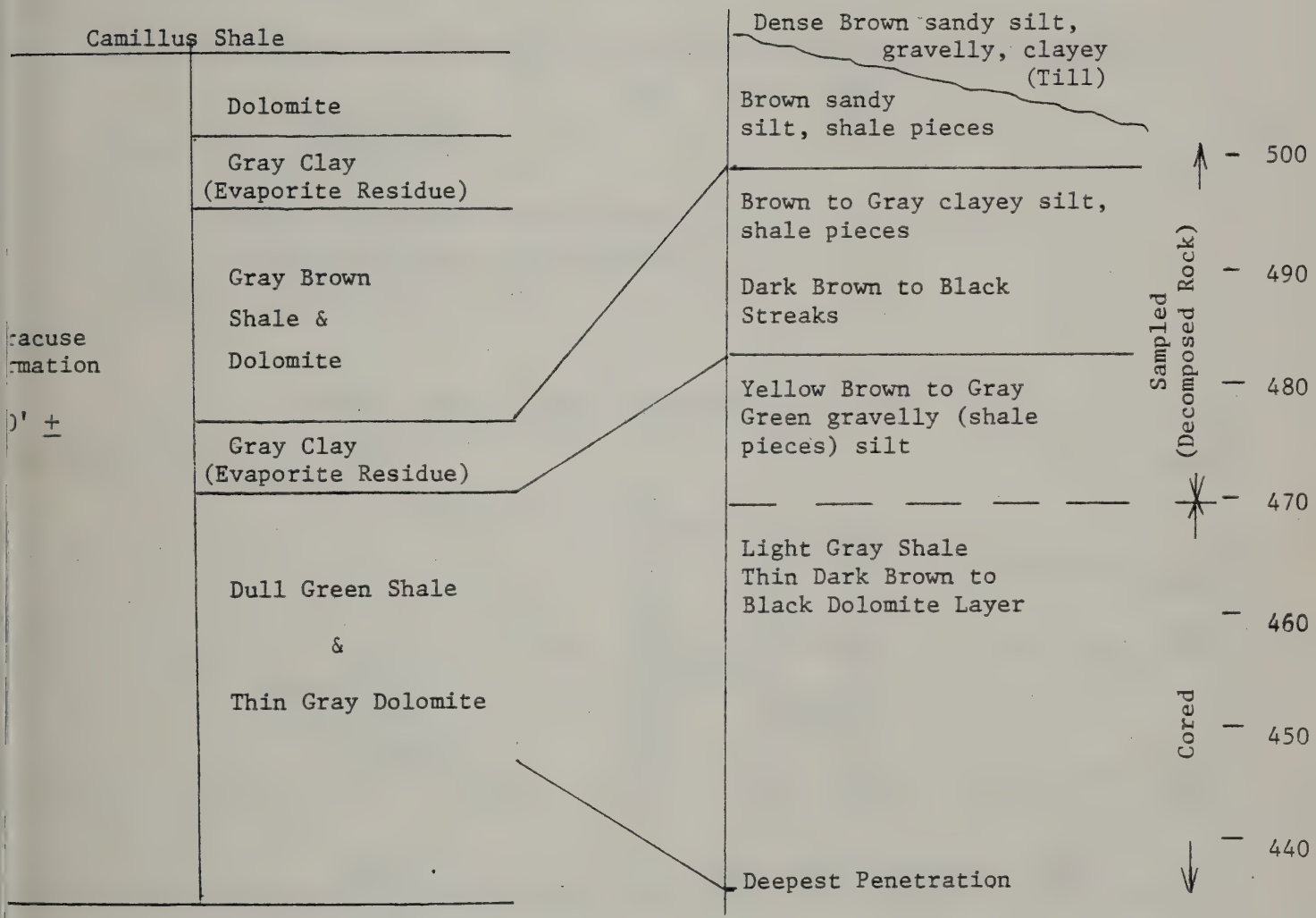
LOCATION PLAN

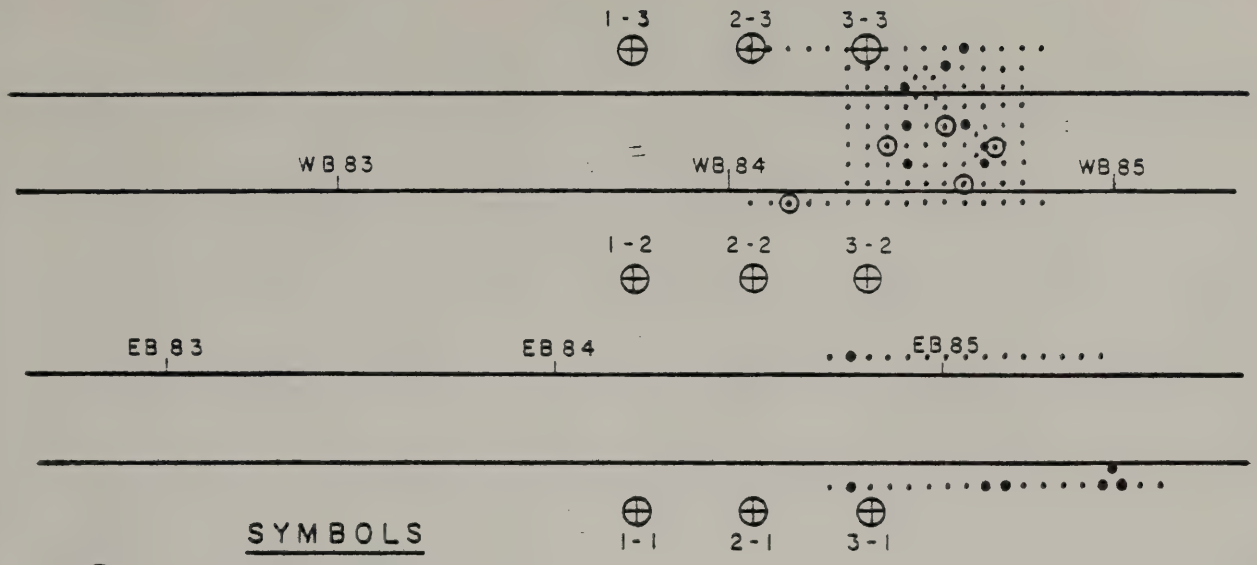
CAMILLUS FAIRMOUNT-PART I
S.H. 5318

Syracuse Formation
Outcrop Section (After Leutze*)

Composite Drill Log
Camillus Site

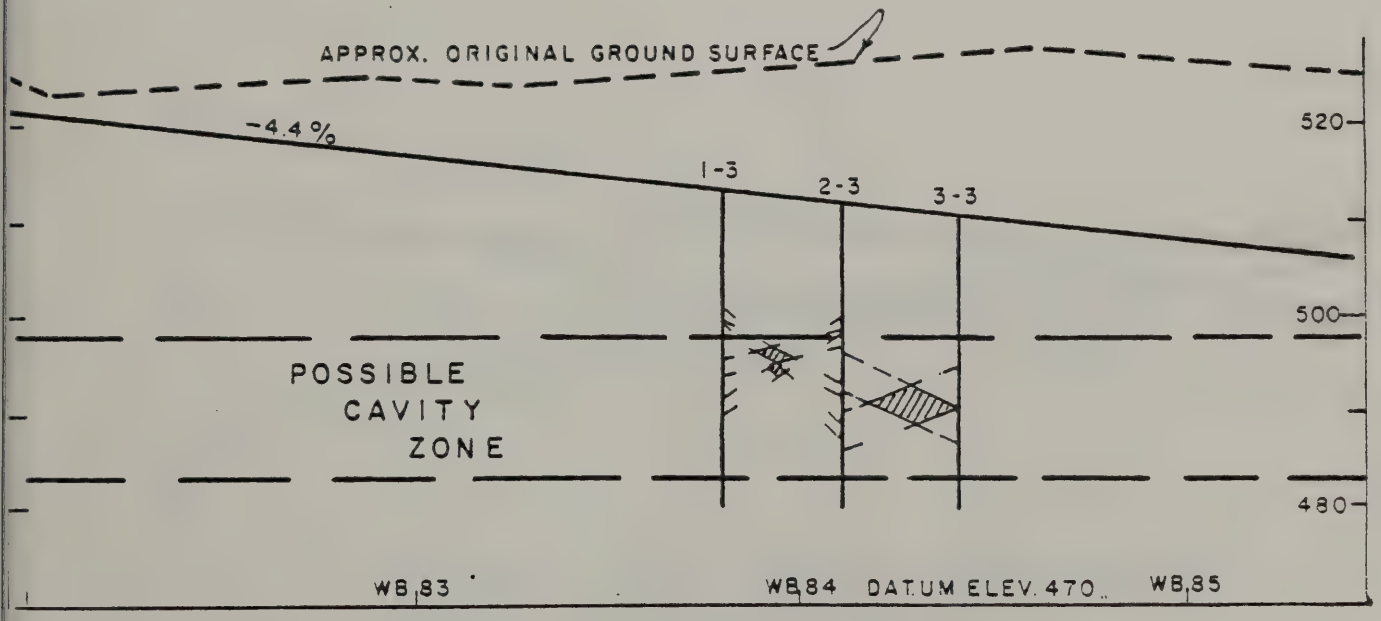


.P. Leutze; N.Y.S.G.A. Guidebook, 36th Annual Meeting, 1964

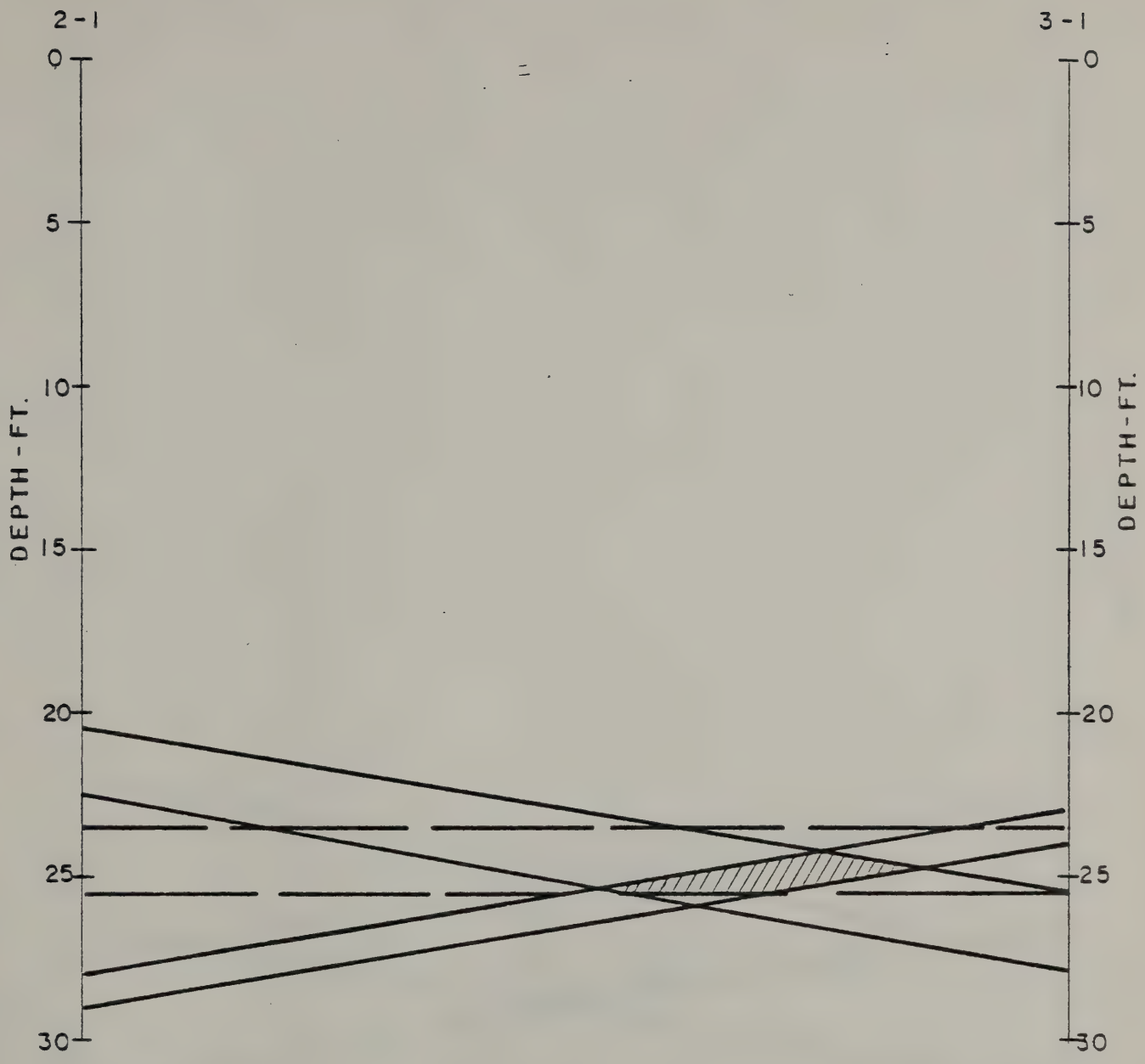


SYMBOLS

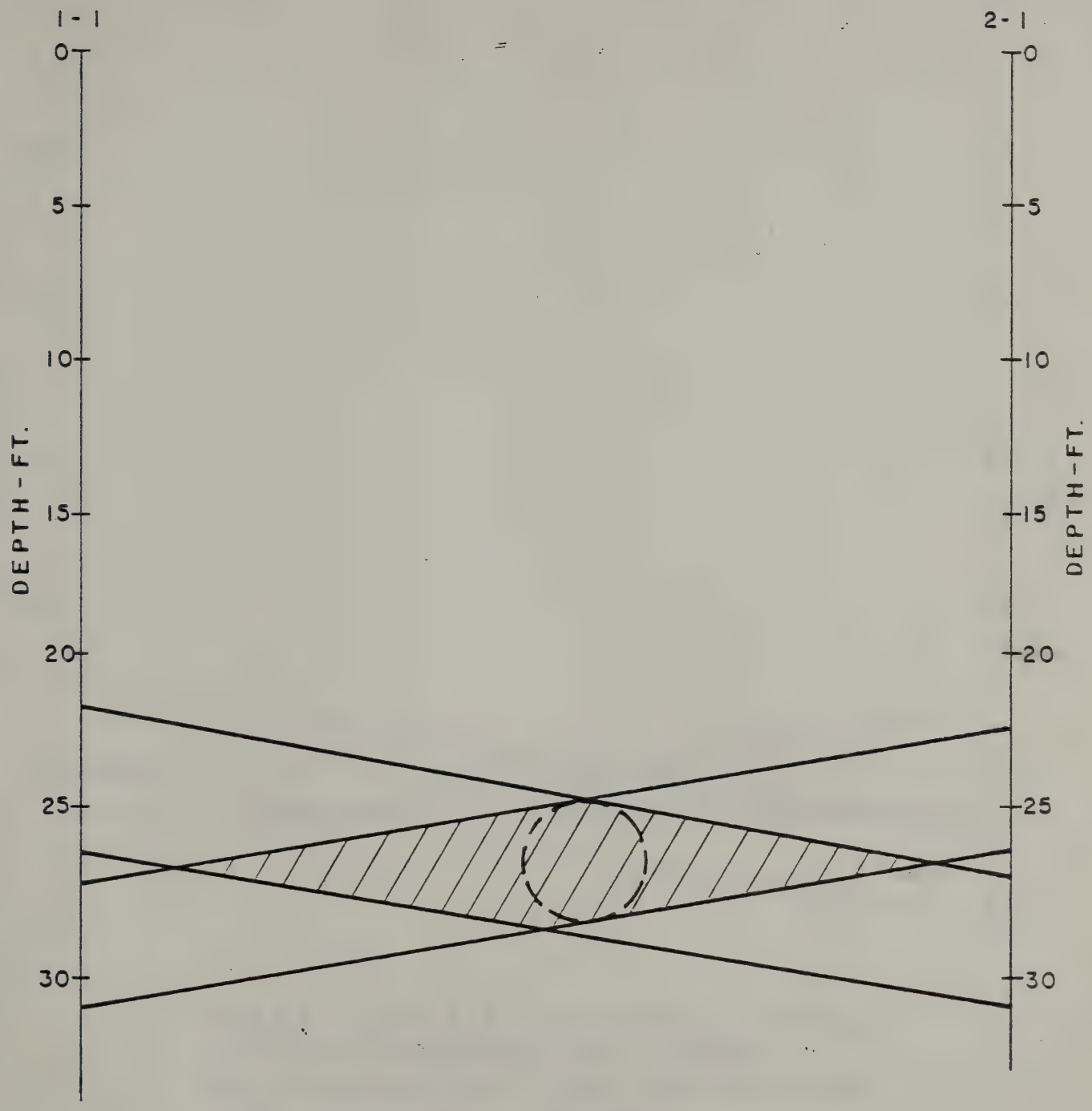
- E.M. SURVEY HOLES
- GROUT HOLES
- GROUT HOLES WHERE TAKE EXCEEDED 1 CU.YD.
- GROUT HOLES WHERE TAKE EXCEEDED 3 CU.YD.
- "CAVITY" E.M. SURVEY DATA



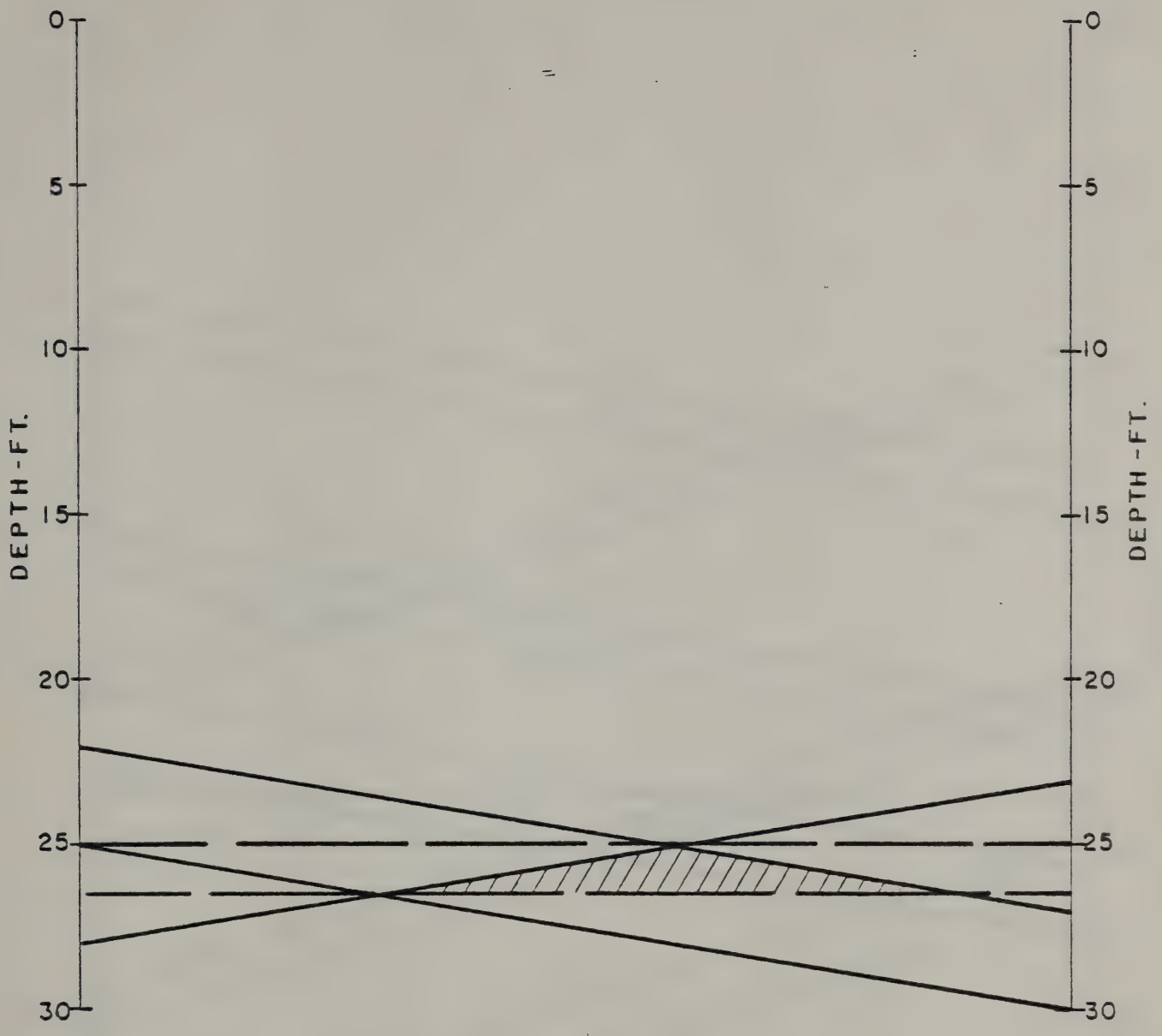
CAMILLUS FAIRMOUNT - PART I
S.H 5318



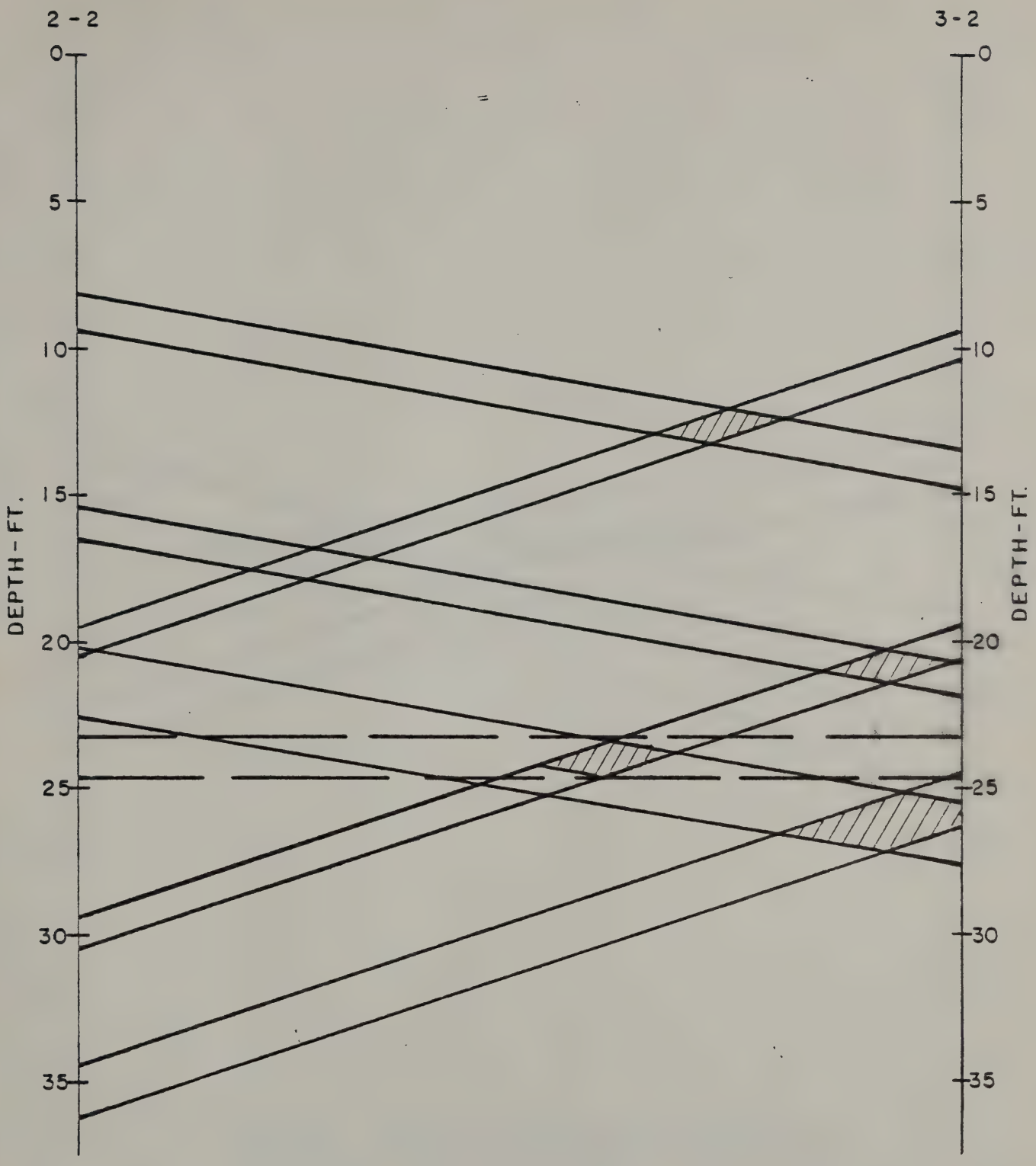
HOLES 2-1 TO 3-1 SHOWS POSSIBLE SMALL CAVITY OR GROUTED AREA.



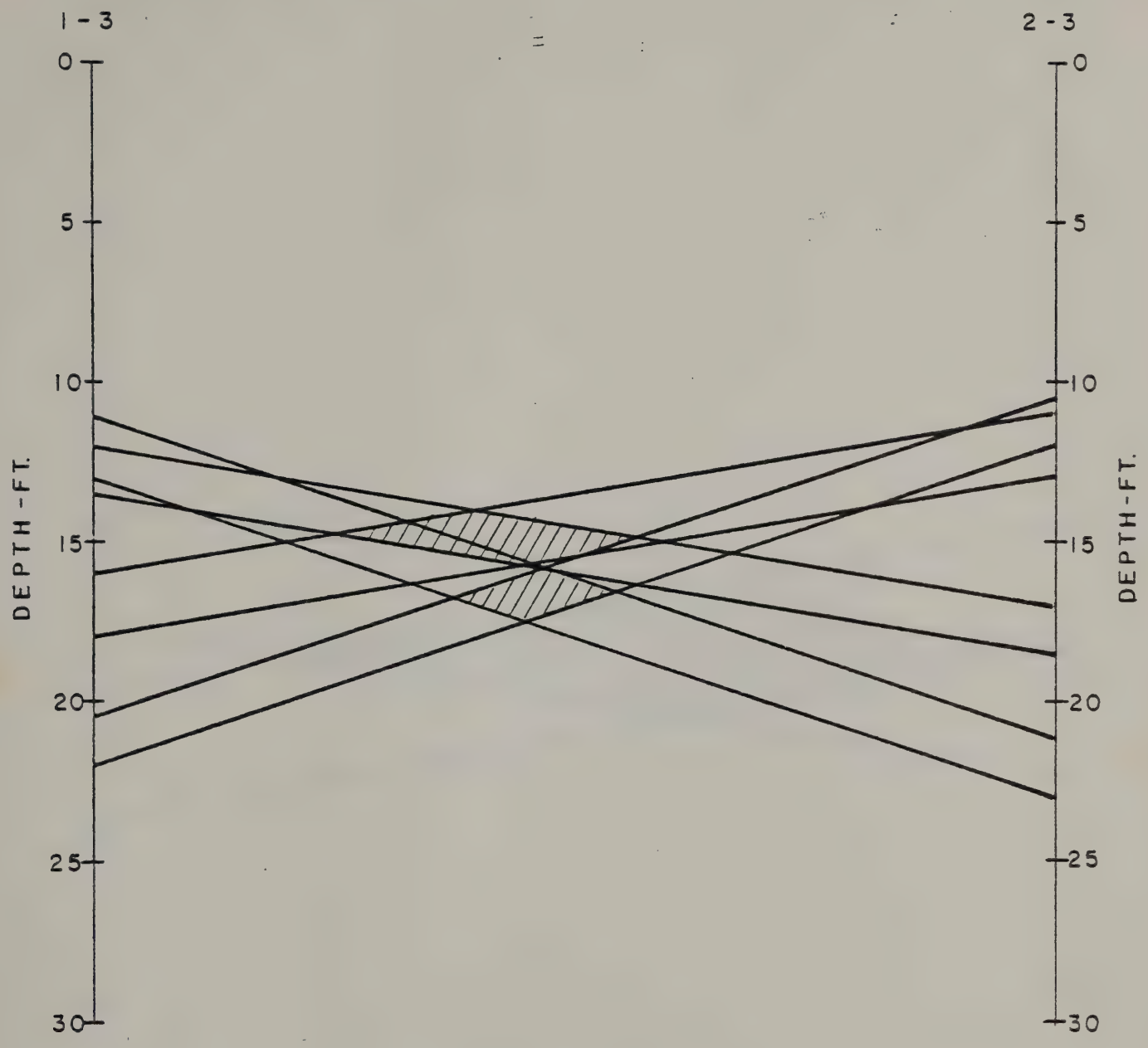
HOLES 1-1 TO 2-1 SHOWS ONE LARGE CAVITY OR ANOMALY.



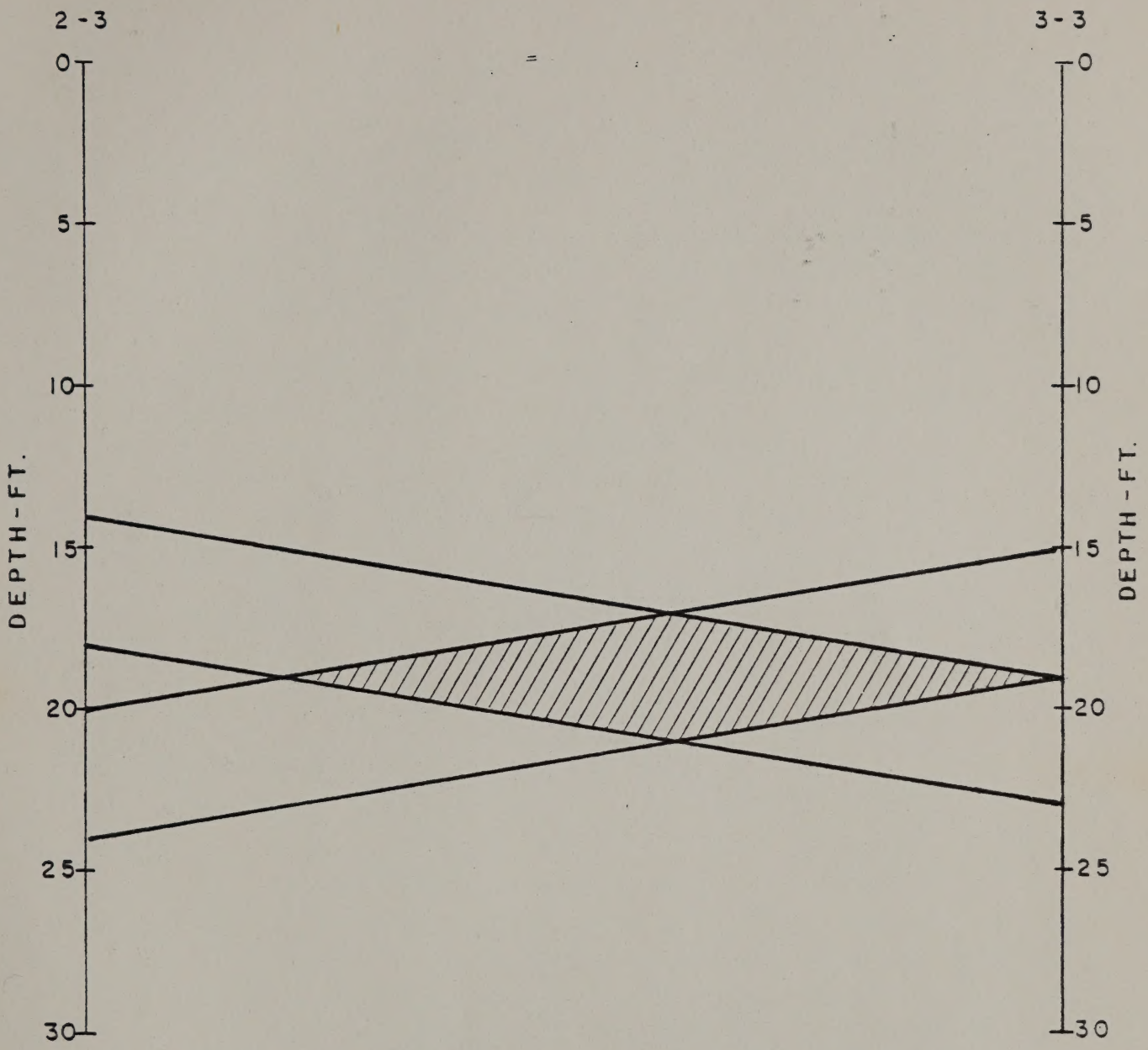
HOLES 1-2 TO 2-2 SHOW SMALL ANOMALY DIFFRACTION PATTERN NOT CLEARLY DELINEATED. NOTE ONLY ONE ANGULAR VIEW SHOWS BOTH NOTCHES.



HOLES 2-2 TO 3-2. POSSIBLE FOUR
SMALL CAVITIES AT LOCATIONS SHOWN.



HOLES 1-3 TO 2-3 PROJECTION OF DATA SHOWING POSSIBLE SMALL CAVITIES DEVELOPING IN THIS PLANE.



HOLES 2-3 TO 3-3 SHOW ONE LARGE CAVITY IN GROUTED AREA. GROUT HOLES WERE 15 FEET DEEP. CLOSEST HOLE TOOK ONE BAG OF CEMENT.

3-3
0
5
10
15
20
25
30
DEPTH-FT

00288
LRI